Irrigation Management to Minimize Soil Fumigant (Telone Product) Emissions

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Emission Reduction Methods

- Plastic tarp
  - Standard HDPE (high density polyethylene)
  - VIF (virtually impermeable film)
  - Metalized film
  - SIF (semi-impermeable film)
- Irrigation
- Amendment of surface soil with chemicals (e.g., ATS) or organic materials (OM)

Research Objective

- Develop agricultural practices (effective, economic, and environmentally friendly methods) to minimize fumigant emissions
    - Irrigation with sprinklers (<$300/ac)
    - HDPE tarp ($900/ac), disposal

This Presentation

- Summarize researching findings using irrigation management to control emissions from fumigation

Irrigation Management

- Drip-application
  - Chemigation with drip irrigation system
- Pre-irrigation
  - Irrigation with sprinkler systems prior to fumigation
- Water seal
  - Applying water with sprinkler systems following shank-injection
  - Applying water with sprinkler systems before or after or during drip application

Water seal over shank-injection:

Reduce porosity;
Increase partitioning in water and solid phase;
Reduce diffusion

Irrigation

Water seal over subsurface drip-application:

Reduces capillary rise from sub-surface drip; Post-fumigation water seal further delays capillary rise

Field Trial, Summer 2005

Hanford sandy loam

Telone C35 (1,3-D + CP):

- shank-injection
- 18” depth; 18” spacing
- 540 lbs/ac

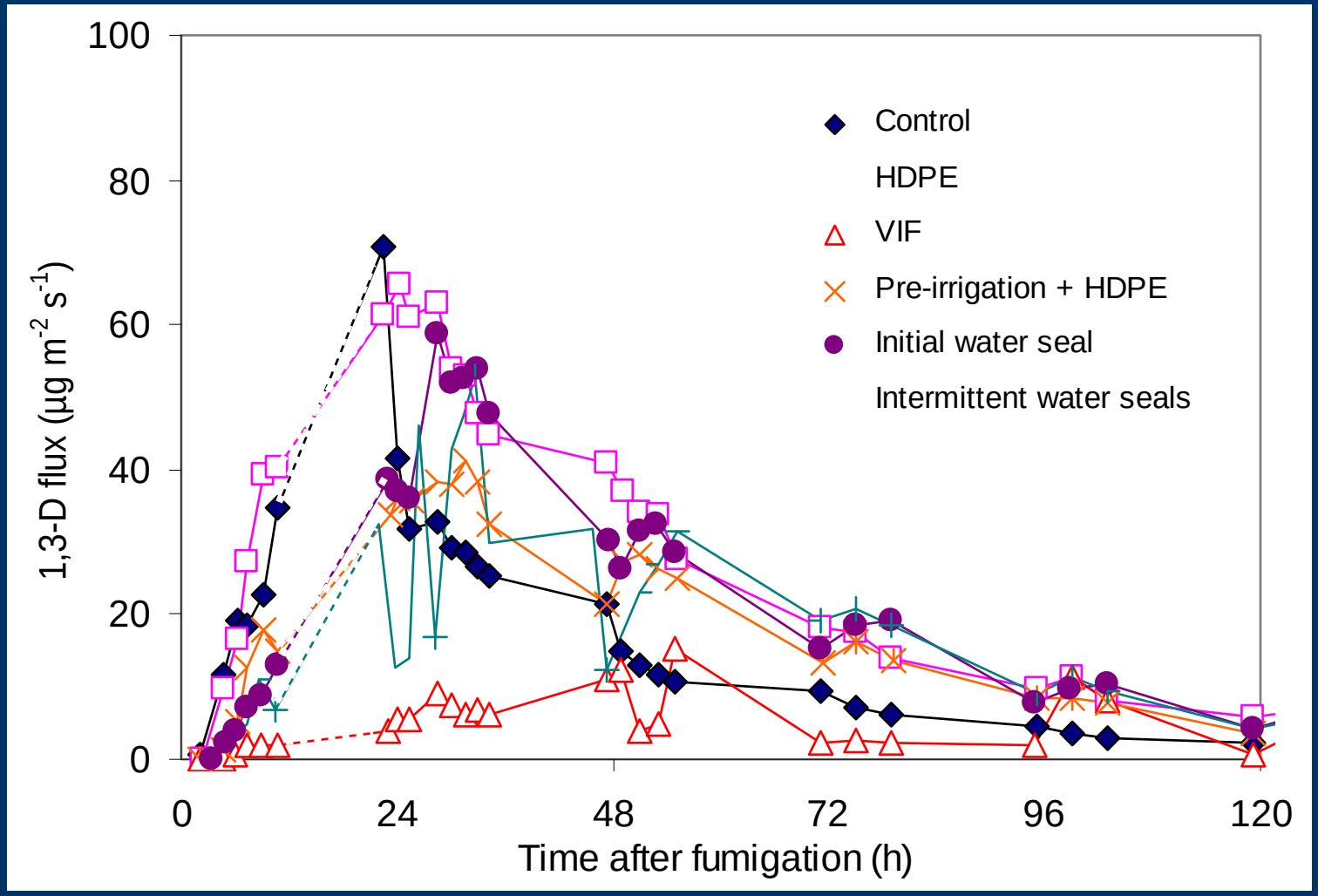
Plot size:

- 30’ x 30’; or 30’ x 10’

Treatments:

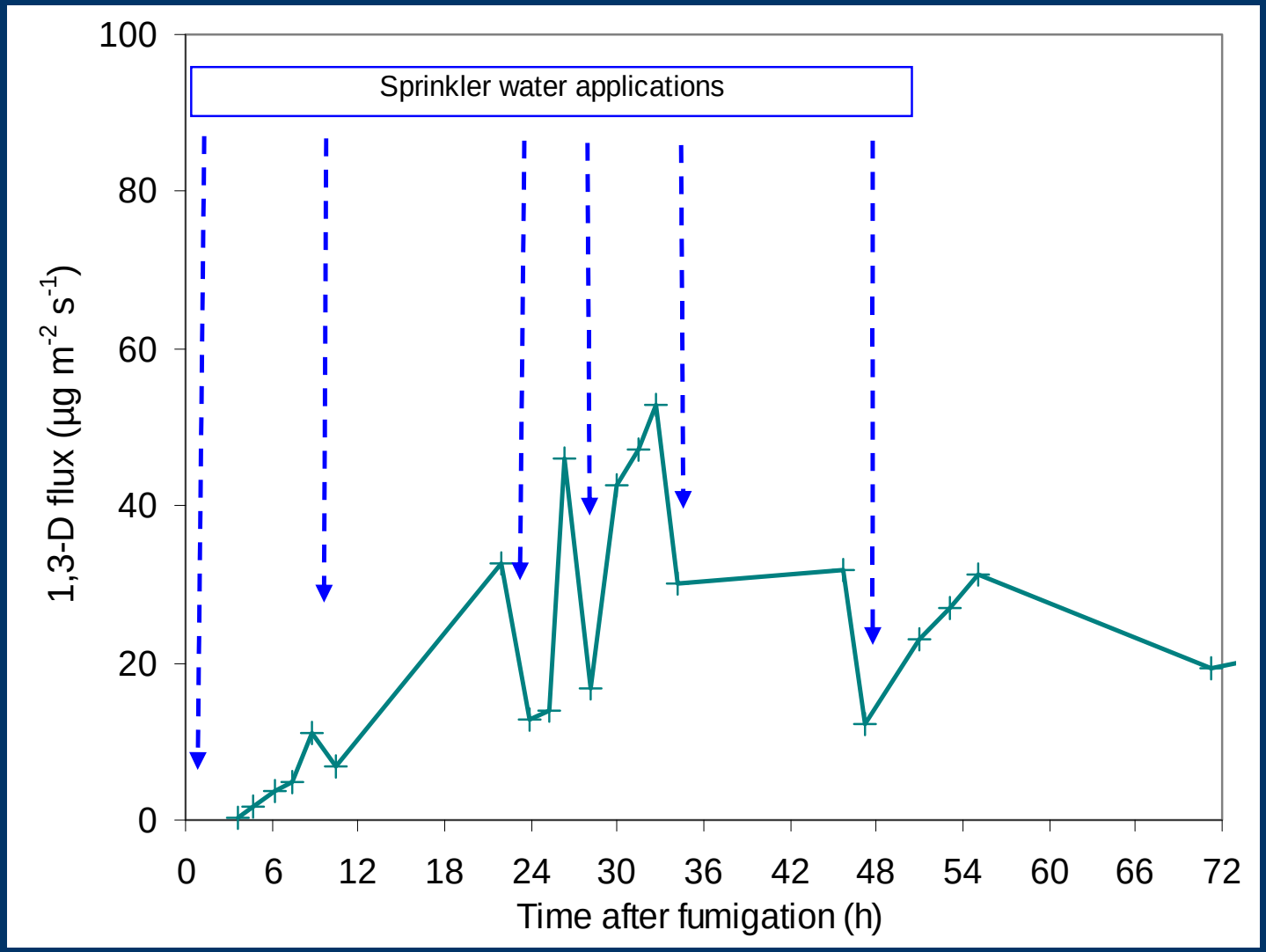
1. Control (dry soil)
2. HDPE (dry soil)
3. VIF (dry soil)
4. Pre-irrigation + HDPE (prior to fumigation, apply 50 mm water to moist surface soil to 30 cm deep
5. Initial water seal (sprinkle 20 mm immediately after fumigation)
6. Intermittent water seals (sprinkle water intermittently: initial 20 mm + 4 mm water each time at ~ 6 h (1st sunset), 24 h, 28 h (noon), 2nd sunset, and 48 h)

1,3-D Emission Flux



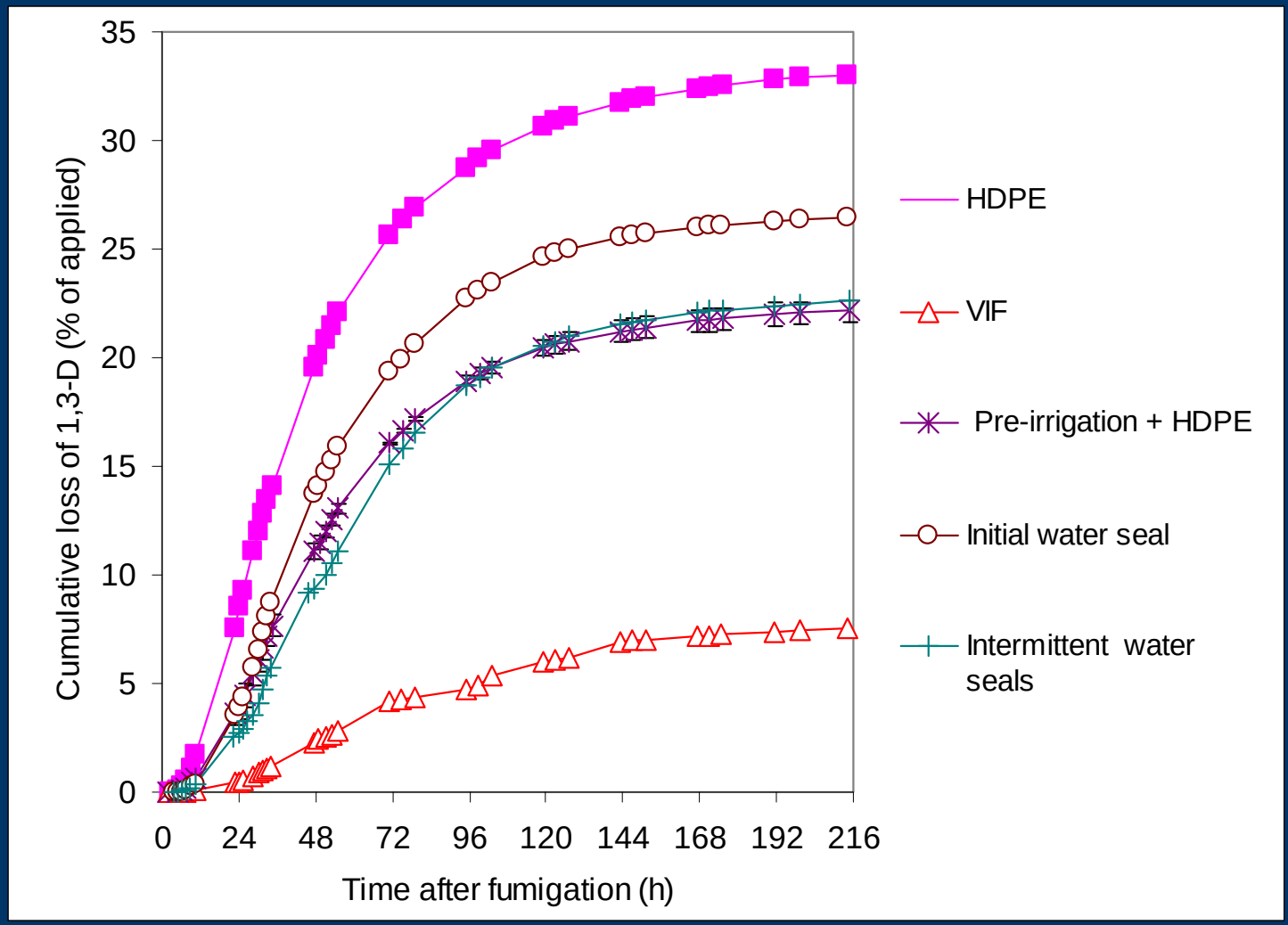
Gao and Trout. 2007. J. Environ. Qual. 36:110-119.

Intermittent Water Seals



Daily maximum air temperature: 37–41°C

Total Emissions from Surface Treatments



Total Emissions Loss (9 d)

Treatment	Total loss (% applied)*	
	1,3-D	CP
HDPE	33.0 (a)	9.2 (a)
VIF	7.5 (c)	1.2 (c)
Pre-irrigation + HDPE	22.1 (b)	2.8 (b, c)
Initial water seal	26.5 (a, b)	8.0 (a, b)
Intermittent water seals	24.2 (b)	3.2 (b, c)

* Means (n=3) with the same letter are not significantly different (α=0.05).

Orchard Field Trial, Fall 2005

- **Objectives: Determine emissions from shank- and drip- application of fumigants with surface seal methods and effect on nematode control.**

Gao, Trout, and Schneider, MBAO Annual Meeting, 2007

Application:

Telone C35; shank-injection (18” depth)

InLine; drip-application (8” depth)

Applied in strips (3.2 m wide), 53% field coverage

Treatments:

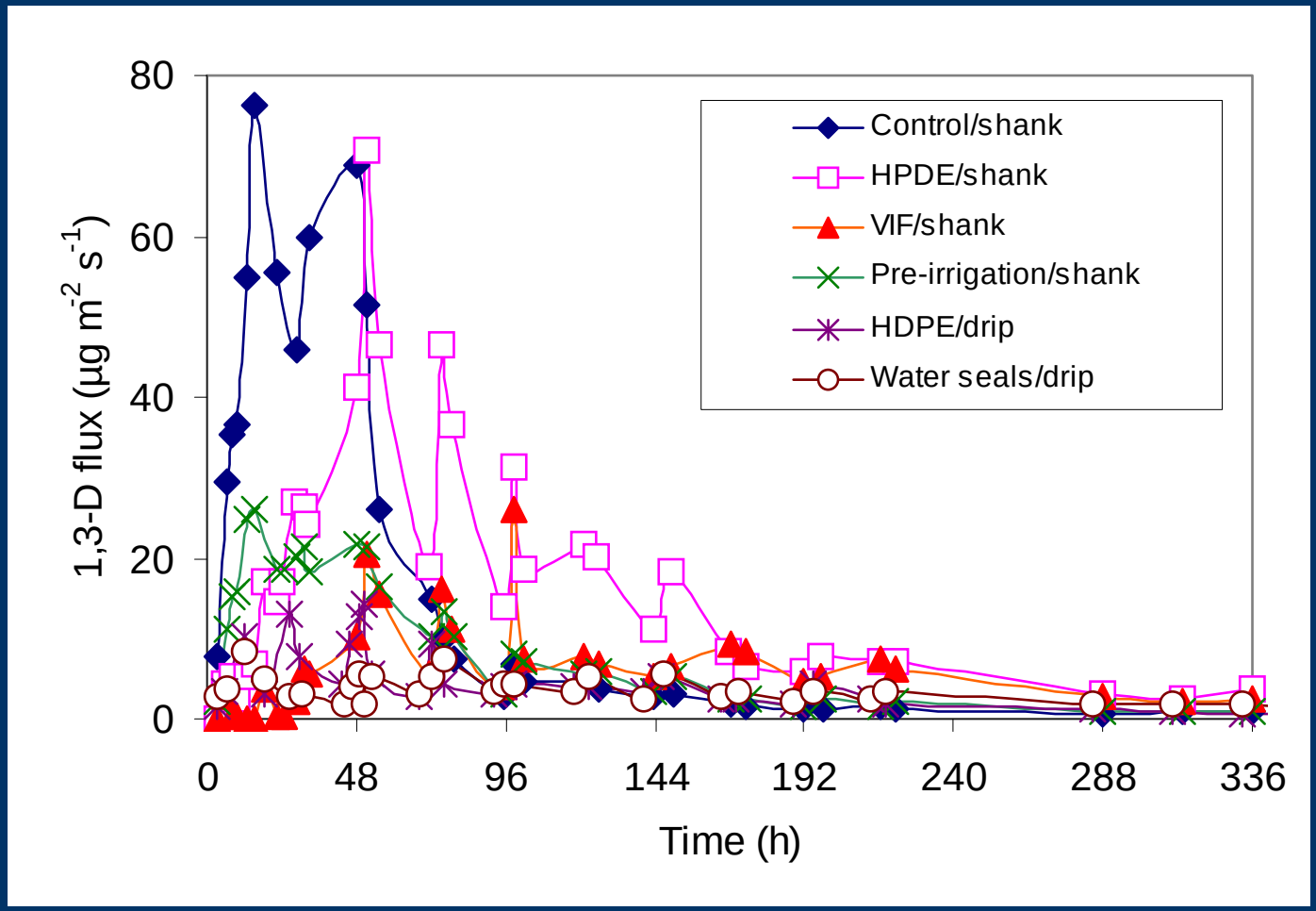
1. **Control (Shank, dry soil)**
2. **HDPE / Shank**
3. **VIF / Shank**
4. **Pre-irrigation / Shank**
5. **HDPE / Drip**
6. **Water seals / Drip**

Treatments

Treatment	Fumigant	Application method	Rate* (kg/ha)	Surface seal method
Control/shank	Telone C-35	Shank	745	Control (dry soil, disk, harrow)
HDPE/shank	Telone C-35	Shank	745	HDPE (dry soil, disk, harrow)
VIF/shank	Telone C-35	Shank	745	VIF (dry soil, disk, harrow)
Pre-irrigation /shank	Telone C-35	Shank	745	Pre-irrigate (~40 mm water sprinkler applied, disk, harrow)
HDPE/drip	InLine	Drip	629	HDPE
Water seals/drip	InLine	Drip	629	Applied 12-mm water pre- and post-fumigation

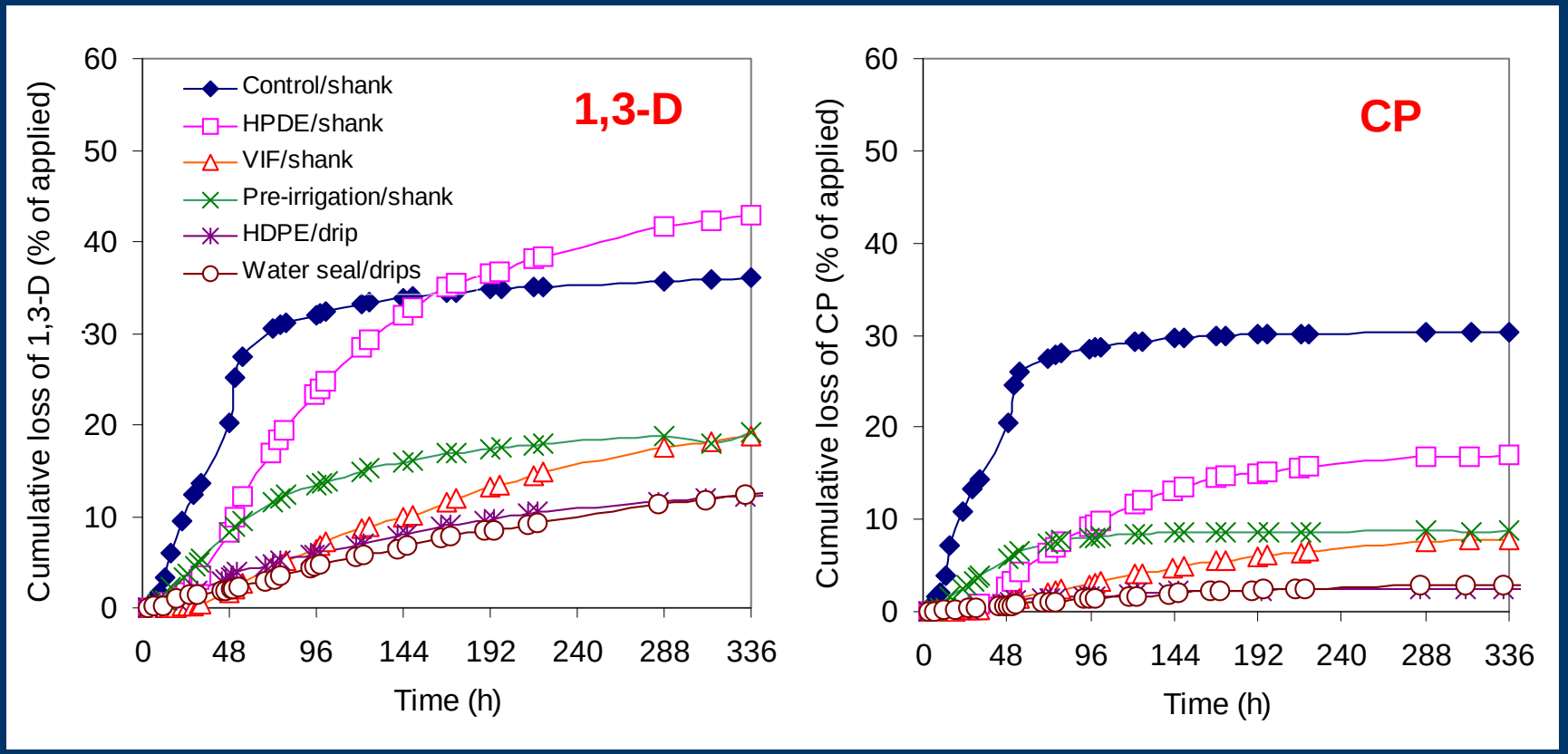
* Rate within 3.2 m wide fumigated strip. Rate per gross field area is 53% of this rate.

1,3-D Emission Flux



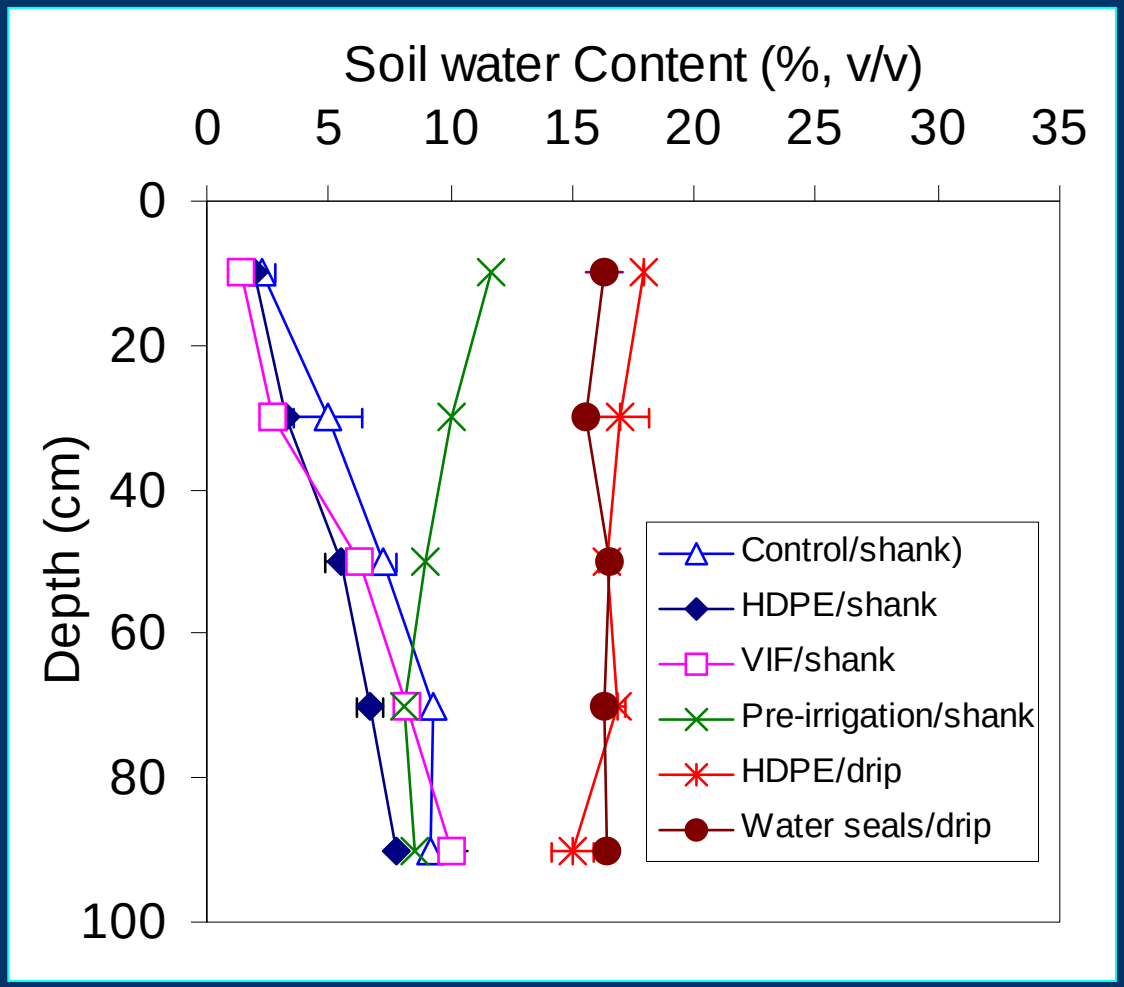
Daily maximum air temperature: 13–27°C

Cumulative Emission Loss*



* The strip fumigation further reduces total mass of emission loss for another 50%.

Soil Water Content
(2 wks after treatments)



Field capacity: 26% (v/v)

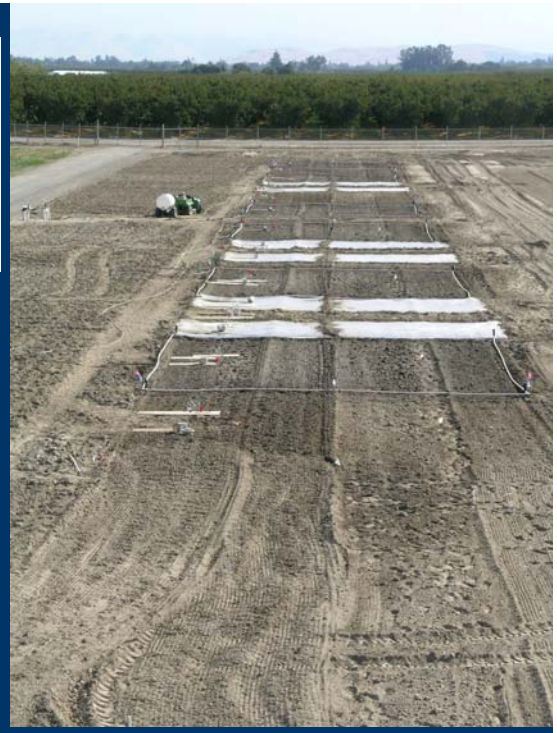
Field Trial, Fall 2006

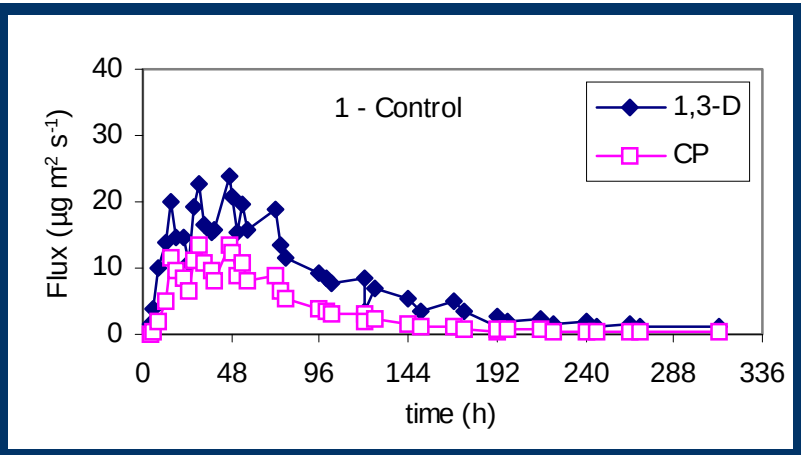
Gao, Hanson, Gerik, and Shrestha

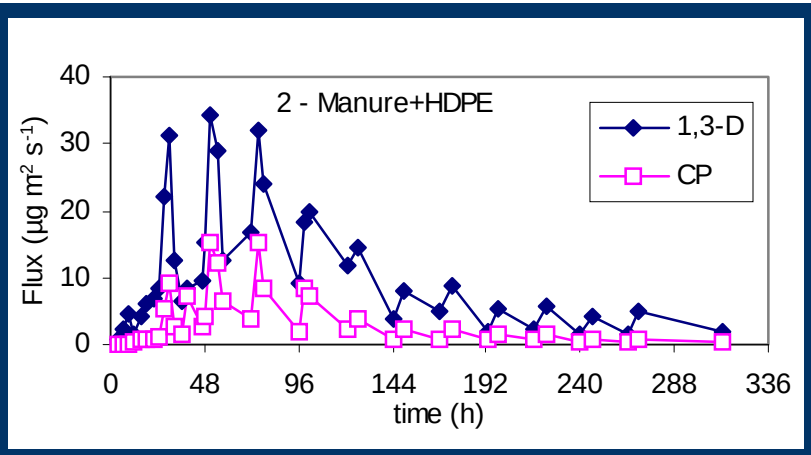
Fumigation: Shank - Telone C35

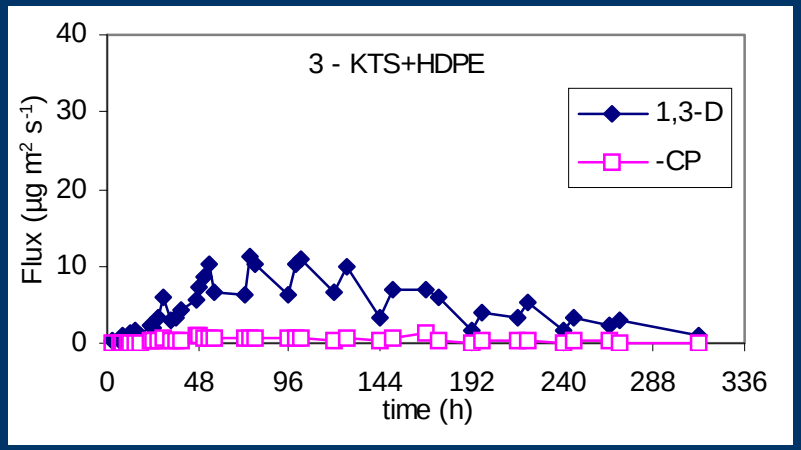
Treatments: (Irrigation was applied to all plots 2-wks prior to fumigation to achieve label condition)

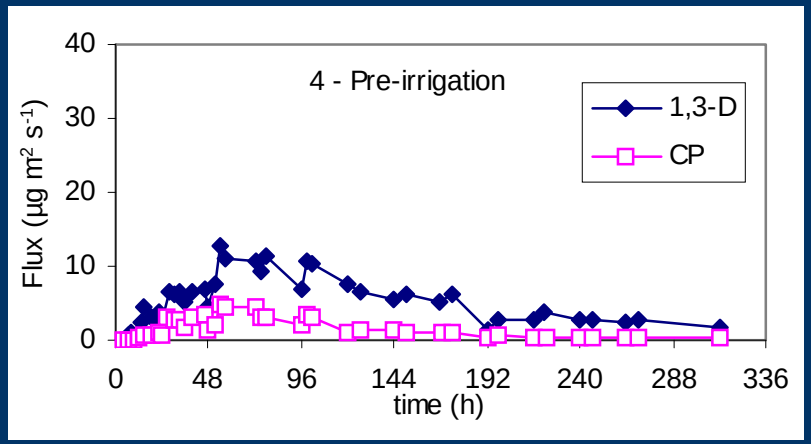
1. Control
2. Manure/HDPE (composted manure 5 tons/ac)
3. KTS/HDPE (2:1 KTS: fumigant)
4. Pre-irrigation (4 days prior to fumigation)
5. Intermittent water seals (0, 12, 24, 48 h)
6. Intermittent KTS/water applications (0, 12, 24, 48 h)

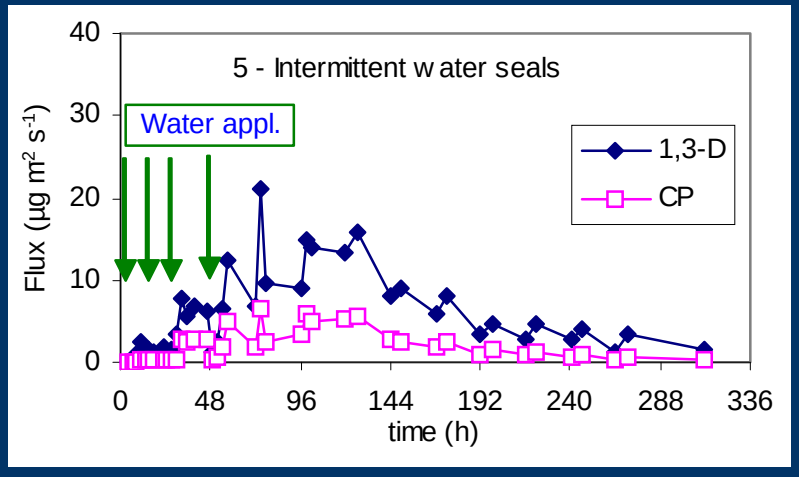


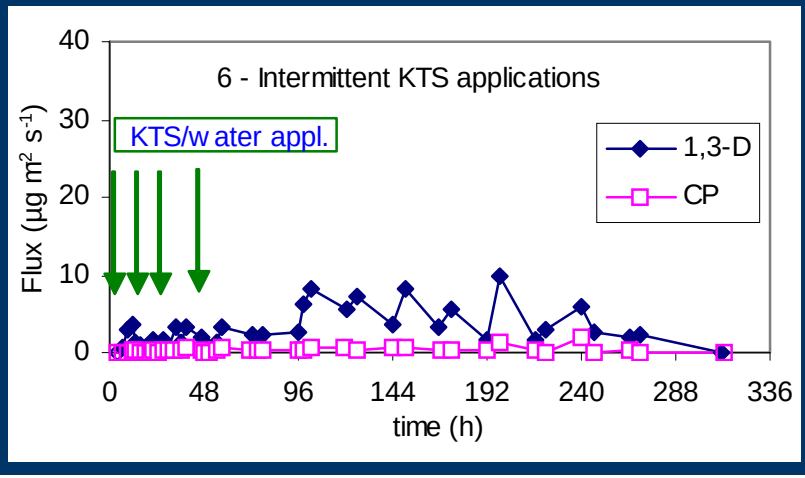

1 - Control
1,3-D
CP
Flux (µg m² s⁻¹)
time (h)
0
10
20
30
40
0
48
96
144
192
240
288
336


2 - Manure+HDPE
1,3-D
CP
Flux (µg m² s⁻¹)
time (h)
0
10
20
30
40
0
48
96
144
192
240
288
336

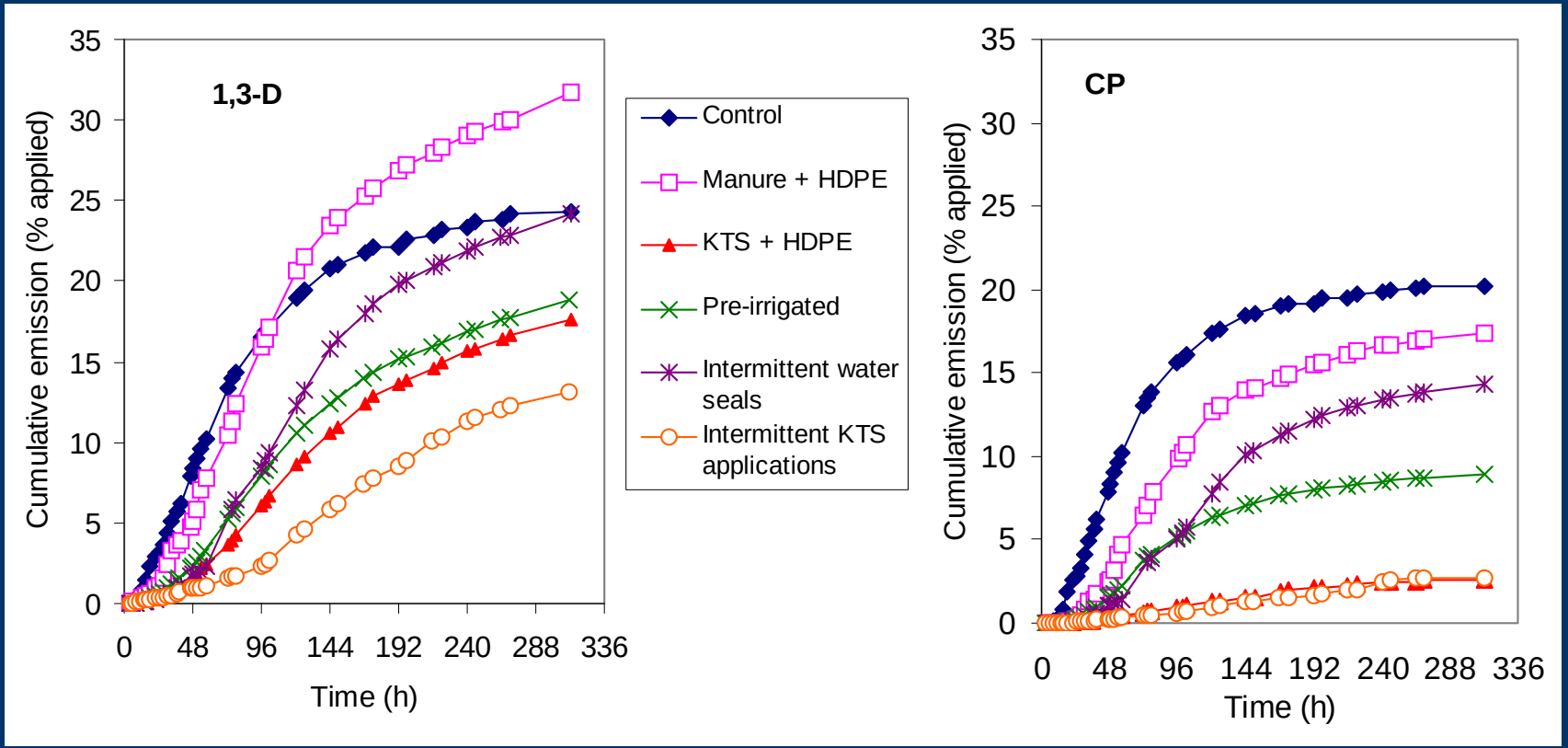

3 - KTS+HDPE
1,3-D
-CP
Flux (µg m² s⁻¹)
time (h)
0
10
20
30
40
0
48
96
144
192
240
288
336


4 - Pre-irrigation
1,3-D
CP
Flux (µg m² s⁻¹)
time (h)
0
10
20
30
40
0
48
96
144
192
240
288
336


5 - Intermittent w ater seals
Water appl.
1,3-D
CP
Flux (µg m² s⁻¹)
time (h)
0
10
20
30
40
0
48
96
144
192
240
288
336

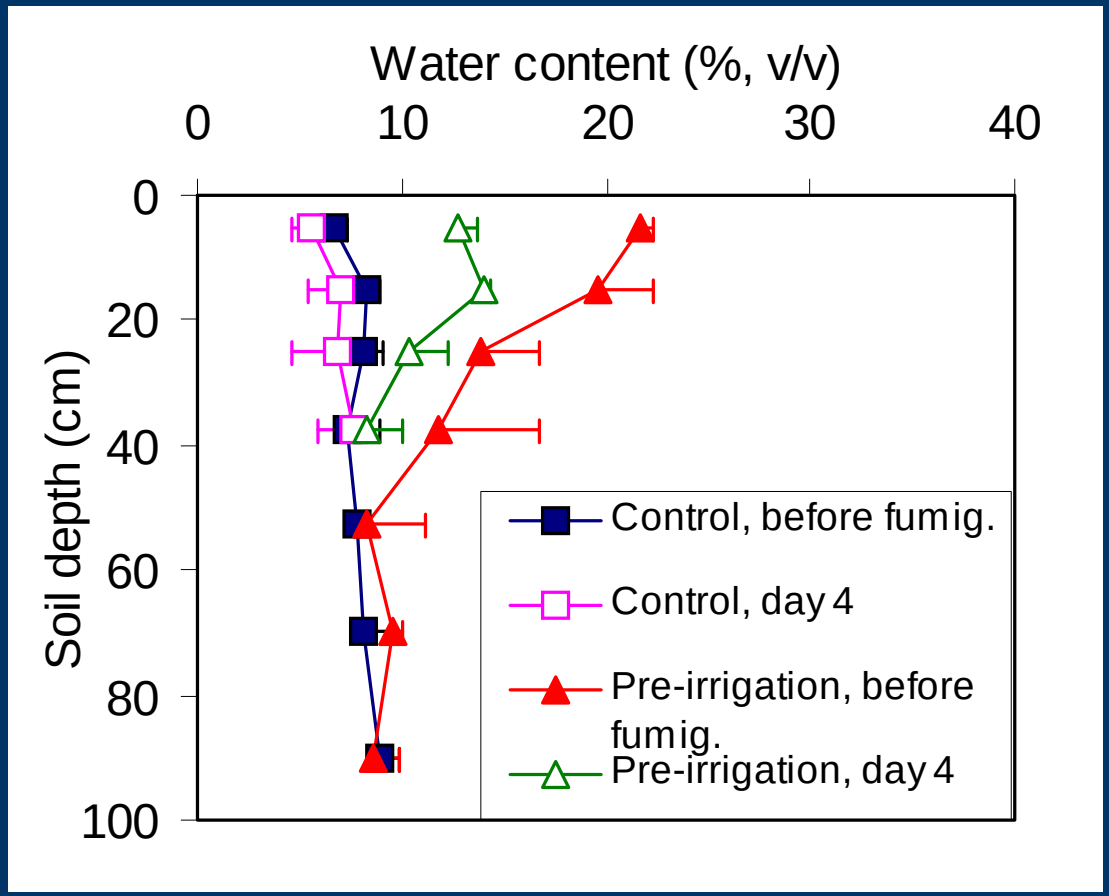

6 - Intermittent KTS applications
KTS/w ater appl.
1,3-D
CP
Flux (µg m² s⁻¹)
time (h)
0
10
20
30
40
0
48
96
144
192
240
288
336

Cumulative Emission Loss



- Additional water and KTS treatments delay and reduce emissions
- Emission from OM treatments needs proper management and better understanding

Soil Water Content Changes

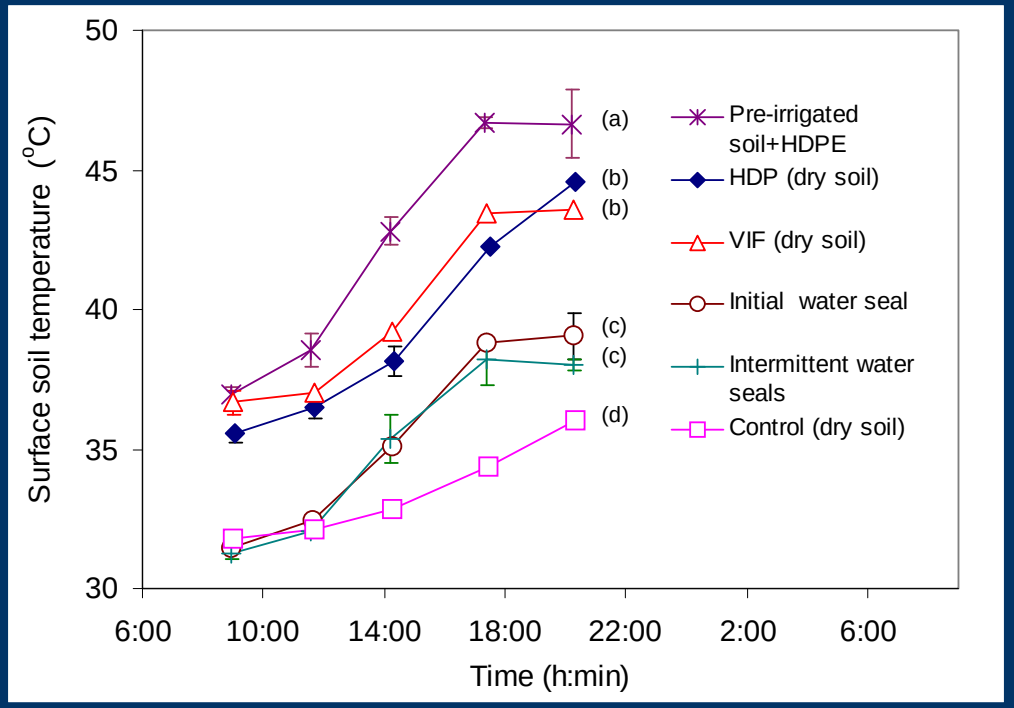


Daily maximum air temperature: 20–29°C

Conclusions (1)

- HDPE over a dry soil profile is not effective to control 1,3-D emissions; but effective to control emissions with a pre-irrigated soil.

Water condensation under HDPE over pre-irrigated soil reduces emissions.



High soil temperature improves efficacy in surface soil.

Conclusions (2)

- Pre-irrigation is probably the easiest practice for controlling fumigant emissions, particularly for Telone.
- Initial water seal reduces and delays emission peaks to minimize risks to workers and by-standers during fumigation.
- Intermittent water seals maximize emission reductions. Challenge is to determine the amount of water and time for applications for different soils and at different seasons.

Conclusions (3)

- Subsurface drip-application gives generally lower emissions than shank injections.
- Water seals can be as effective as HDPE tarp over drip-applications to control fumigant emissions.
- Water distribution and fumigant distribution vs. fumigation efficacy not well demonstrated.

Research Needs

- The optimum soil moisture condition for minimizing emissions while achieving good pest control for different types of soil (e.g., texture).
- Water seal amount and application schedules to achieve maximum emission reductions while not reducing efficacy.
- Amendment of soil with OM to minimize emissions. Current results indicate OM may be only effective when accompanied with irrigation and/or with HDPE tarp. The mechanisms are not well understood.

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